Regional Applied Research Effort (RARE) and Regional Methods (RM) Proposal

TITLE: ***Evaluating a water treatment method to prevent the formation and export of MeHg in restored wetlands and ricelands of the Sacramento-San Joaquin Delta (Delta)***

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REGIONAL SCIENCE NEED: Restoring wetlands on deeply subsided islands within the Central and Western Delta could help reverse subsidence and increase habitat for fish and wildlife, capture and store huge quantities of atmospheric carbon, advance climate protection, and help stabilize the fragile network of levees (a linchpin of California's water supply system). Also, if innovations can be made to restoration techniques, restoring wetlands can help the public and private sectors with achieving pollutant load reductions consistent with the Total Maximum Daily Load (TMDL) allocation for methylmercury (MeHg). Threats to the ecology and infrastructure of the Delta include earthquake and climate change scenarios that would cause catastrophic levee failures, salt water intrusion, and the replacement of low-lying farmlands with permanent lake-like habitats. The diking, draining, and farming of the Delta that began in the 1850s have caused the oxidation of peat soils, and the subsidence of Delta islands to between 5 and 30 feet below sea level. This subsidence can be reversed by wetlands restoration, but anaerobic conditions within wetlands can transform mercury (Hg) present in the soils into MeHg, the more bioavialable form of Hg that can harm fish, wildlife, and people. Sources of Hg include historic inputs from the Gold Rush era, drainage from abandoned mines, and ongoing air deposition from power plants and industry. The MeHg can accumulate in organisms within the restored wetlands, and can be "exported" to Delta surface waters (it is estimated ~40% of the aqueous MeHg present in the Bay Delta Estuary is produced *in situ* within Delta wetlands).

SPECIFIC GOALS AND APPROACH: With RARE funding, scientists from the U.S. Geological Survey (USGS) will evaluate the efficacy of a water treatment method (known as **low intensity chemical dosing or LICD**) in preventing the formation and export of MeHg. The RARE proposal builds upon USGS' Carbon Capture Farming Program (CCFP) at Twitchell Island, and presents scientists with an opportunity to study MeHg cycling in a unique environmental setting by comparing treated and untreated wetlands. The implementation of LICD *in situ* could potentially reduce the formation of MeHg in the restored wetlands, and the export of aqueous MeHg from the Delta islands. Rice is farmed near the wetlands, and ricelands resemble wetlands both in function and in the levels of dissolved organic carbon (DOC) present. USGS is already studying how iron and aluminum based coagulants (FeSO4 and poly-aluminum chloride) can sequester DOC from island drainage prior to discharge into Delta waters (under a grant from the Department of Water Resources). These coagulants cause DOC to precipitate as a "floc," and are routinely used to remove DOC from drinking water prior to disinfection. MeHg is associated with DOC and can be similarly sequestered in the floc. Laboratory based studies indicate more than 90% of Hg and 70% of MeHg can be removed from the water column using the LICD treatment process. Funding from the RARE program will enable USGS to go beyond the scope of its original research funded by DWR (LICD's effectiveness toward sequestering DOC) to also evaluate the efficacy of LICD in preventing the formation and export of MeHg.

EXPECTED RESULTS AND PRODUCTS: Society can derive a suite of important benefits from restoring wetlands on deeply subsided Delta islands, but the costs to ecosystem and human health can be unacceptably high unless we prevent the formation and export of MeHg. If the LICD water treatment method is proved effective on Twitchell Island, it could have a profound consequences for the way wetlands are restored and managed (and the way these islands are farmed) across the Delta region. This outcome would improve the prospects for restoring wetlands on a large-scale, and capturing and storing huge quantities of atmospheric carbon in the vast "accommodation space" provided by the deeply subsided Central and Western Delta. In the experimental wetland cells, wetland plants (cattails, *Typha spp* and tules *Scirpus californicus*) sequester CO_2 and the accretion of the resulting organic matter increases land surface elevations by 2 to 4.5 cm/yr, or 40 times historic rates. The carbon sequestration combined with the reversal of subsidence simultaneously advance climate protection, help stabilize the Delta's fragile network of levees (therefore helping to secure our water supply infrastructure), and advance attainment of the MeHg load reductions prescribed by the Delta Methylmercury TMDL.

Demonstrating how the formation and export of MeHg can be controlled in wetlands and ricelands could help usher in a new era of wetlands restoration and sustainable farming in the Central and Western Delta. This outcome could expand the conversation on environmentalism among the diverse stakeholders of the Delta, and help ease political and cultural tensions that have been brewing for generations.

TRANSLATION, IMPLEMENTATION OR COMMUNICATION PLAN: EPA Region 9 considers the applied aspects of USGS' work – reducing the formation and export of MeHg to advance the restoration of wetlands – as vital to the protection and management of the Delta. USGS will stage two public meetings in Delta communities. Also, USGS will produce new data and scientific findings that could be useful in wetlands restoration projects throughout the Delta.

PROPOSED BUDGET: RARE funding to USGS would augment funding from DWR and the USGS to investigate the feasibility of establishing wetlands and ricelands on subsided Delta Islands.

Personnel	
Project lead: Soil scientist (approx 2 weeks)	$11,500
Hydrologist mercury specialist (approx 3 weeks)	$15,000
Technician (approx. 6 weeks)	$20,000
Analytical	$50,000
Supplies	$ 3,500
Total	$100,000

PROJECT TIMELINE:

	FY 2012											
Task	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**
1. Sample collection/process	X	X	X	X	X	X	X	X	X	X	X	X
2. Analyses			X	X	X	X	X	X	X	X	X	X
3. Data analyses and report										X	X	X

4. Outreach					**X**						**X**	

Project Goals	Hypotheses	Approach	Expected Results	Benefits
1) Reduce DOC (and DBP precursor) export from subsided Delta islands (**funded by DWR**)	H1a: LICD treatment cells will decrease DOC (and DBPP) exports relative to untreated cells (control) H1b: Iron-based coagulant will be more effective than aluminum-based coagulant	Measure DOC concentration and loads at inlets and outlets of each LICD wetland cell.	Significantly lower ($p<0.05$) DOC loads from treatment cells compared to controls. Possible differences between coagulants	Reduced drinking water contaminant (DOC) release from Delta Islands
2) Increase accretion within wetland treatment cells (**funded by DWR**)	H2: Wetlands receiving LICD floc will have greater land surface accretion and C-storage compared to untreated wetlands (control)	Measure sediment (and carbon) accreted in the wetland cells relative to land surface prior to flood-up	Significantly greater accretion and carbon storage ($p<0.05$) in treatment cells relative to control cells	Reduced hydrostatic pressure on most threatened Delta levees. Carbon sequestration ($ on C market?)
3) Decrease THg and MeHg exports from subsided Delta islands (funded by RARE)	H3a: LICD treatment cells will decrease MeHg (and THg) exports relative to untreated cells (control) H3b: Iron-based coagulant will be more effective than aluminum-based coagulant	Measure THg and MeHg concentrations and loads at inlets and outlets of each wetland cell.	Significantly lower ($p<0.05$) THg and MeHg loads from treatment cells compared to controls	Demonstration of mitigation strategy to meet TMDL goals of reduced MeHg loads from high DOC systems (wetlands, agriculture)
4) Decrease mercury bioaccumulation in biota within Delta C-sequestration wetlands (potential funding not secured)	H4a: Biota within the wetlands receiving LICD floc will have lower THg and MeHg than control wetlands H4b: Iron-based coagulant will show greater decrease than than aluminum-based coagulant	Measure THg and MeHg concentrations in caged mosquito fish (Gambusia spp) placed in each of the LICD treatments	Significantly lower THg and MeHg concentrations or burdens ($p<0.05$) in fish collected from treatment wetlands relative to control wetlands	Demonstration of mitigation strategy to meet TMDL goals of reduced biota concentrations in Delta habitats
5) Outreach conducted to the public by the end of the Project (funded by DWR and RARE)	H5: Delta communities and stakeholders will embrace alternative land use practices if feasiblilty and benefits are demonstrated	1) Conduct quarterly public workshops to discuss Delta issues and options. 2) Coordinate with WEF/WET to enhance discussion of Delta options (LICD, C-farming, rice production) and concerns 3) Coordinate with TMDL process to incorporate LICD into possible mitigation strategies	Demonstrate a strategy for preserving the heart of the Delta that protects its economic, ecologic and cultural identity	250-500 contacts with local landowners, Local, state and regional staff and volunteers, and other community members and stakeholders